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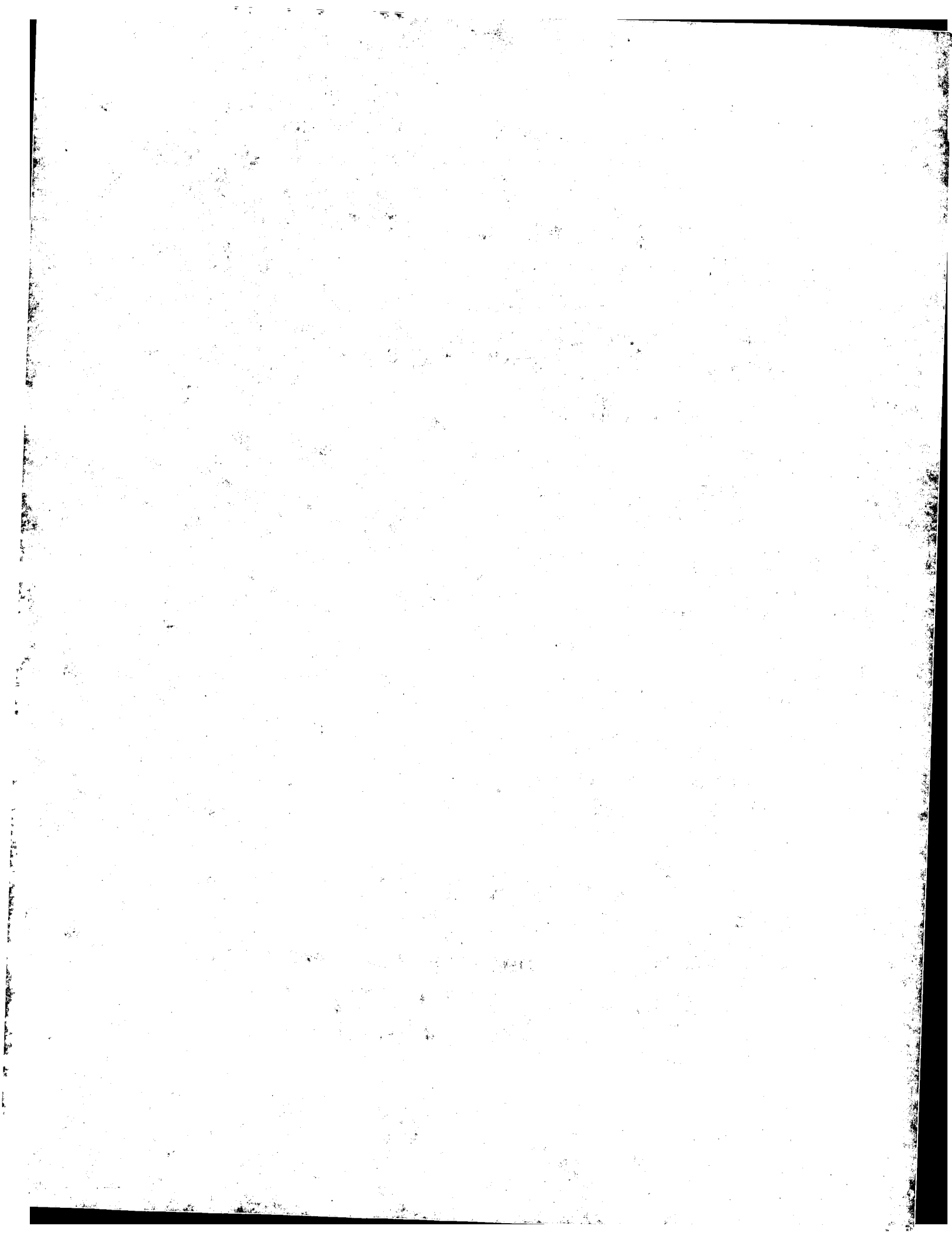
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Alastair J.M. Brown *et al.*

Application No.: 10/803,432

Group Art Unit: TBA

Filed: 03/18/2004

Examiner: TBA

Title: Acoustic Drive Arrays and Loudspeakers Incorporating Same

Mail Stop Application
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

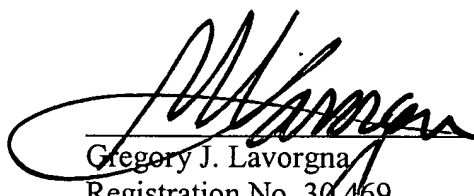
TRANSMITTAL OF PRIORITY DOCUMENT

Sir:

Enclosed herewith is a certified copy of Great Britain patent application No. 0306552.1 which was filed March 21, 2003, from which priority is claimed under 35 U.S.C. § 119 and Rule 55.

Acknowledgement of the priority document is respectfully requested to ensure that the subject information appears on the printed patent.

Respectfully submitted,



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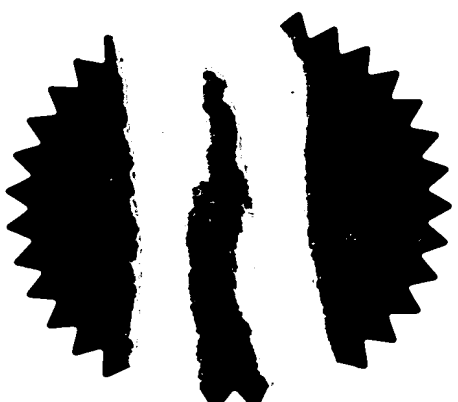
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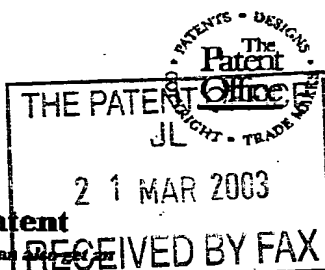
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Request for grant of a patent

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| 1. Your reference | P33886- | | |
| 2. Patent application number (The Patent Office will fill in this part) | 0306552.1 | | |
| 3. Full name, address and postcode of the or of each applicant (underline all surnames) | Linn Products Limited Floors Road, Waterfoot Eaglesham Glasgow G76 0EP Patents ADP number (if you know it) If the applicant is a corporate body, give the country/state of its incorporation | | |
| | United Kingdom | | |
| 4. Title of the invention | Acoustic Drive Arrays and Loudspeakers Incorporating Same | | |
| 5. Name of your agent (if you have one) | Murgitroyd & Company | | |
| "Address for service" in the United Kingdom to which all correspondence should be sent (including the postcode) | Scotland House 165-169 Scotland Street Glasgow G5 8PL Patents ADP number (if you know it) | | |
| | 1198015 ✓ | | |
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| 7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application | Number of earlier application | Date of filing (day / month / year) | |
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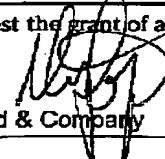
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| Priority documents | - |
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| 11. | I/We request the grant of a patent on the basis of this application. | |
| | Signature  | Date |
| | Murgitroyd & Company | 21 March 2003 |
| 12. Name and daytime telephone number of person to contact in the United Kingdom | John Cooper | 0141 307 8400 |

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1 Acoustic Drive Arrays and Loudspeakers Incorporating
2 Same

3
4 The present invention relates to arrays of acoustic
5 drive units, particularly midrange and high
6 frequency acoustic drive units, and to loudspeakers
7 incorporating such arrays. The drive units are
8 preferably integrated into a self-contained assembly
9 that may or may not further include an additional
10 low frequency drive unit, and that can be
11 incorporated into a variety of loudspeaker cabinets,
12 with or without additional drive units, in a variety
13 of different specifications and configurations.

14
15 The present invention seeks to provide arrays of
16 acoustic drive units that provide controlled high
17 frequency dispersion and very low acoustic
18 coloration, such that loudspeakers incorporating the
19 arrays can have a variety of cabinet configurations
20 and can be placed in a variety of locations,
21 including locations near to walls or rebated into
22 wall surfaces, without changing the dispersion

1 characteristics of the loudspeaker. The invention
2 further seeks to optimise dispersion and lobing (at
3 crossover) characteristics.

4
5 In accordance with a first aspect of the invention
6 there is provided an acoustic drive array comprising
7 mounting means for supporting a midrange acoustic
8 drive unit and at least one high frequency acoustic
9 drive unit and means defining an acoustically
10 reflective surface, said mounting means being
11 arranged in a fixed, predetermined spatial
12 relationship with said reflective surface such that
13 said at least one high frequency drive unit is
14 disposed in front of said reflective surface, the
15 configuration of the reflective surface and the
16 disposition of the at least one high frequency drive
17 unit relative thereto being such as to substantially
18 eliminate any coherent reflection of sound from the
19 at least one high frequency drive unit.

20
21 Preferably, the reflective surface is irregular and
22 continuously varying, in terms of the distance from
23 the periphery of the reflective surface to the at
24 least one high frequency drive unit and the angle
25 between the reflective surface and a plane in which
26 the drive units of the array are mounted.

27
28 More preferably, the shortest distance from the
29 centre of the at least one high frequency drive unit
30 to any point on the periphery of the reflective
31 surface is 30 mm or greater, and the largest
32 distance from the centre of the at least one high

1 frequency drive unit to any point on the periphery
2 of the reflective surface is 155 mm or less.

3

4 Preferably, the reflective surface is generally
5 concave. Preferably also, the outer periphery of
6 the reflective surface has a convex, curved cross
7 section to provide a smooth convex transition
8 between the main reflective surface and its
9 outermost edge.

10

11 In preferred embodiments, the reflective surface has
12 a generally elliptical periphery and a quasi-
13 ellipsoidal configuration, without focal points.

14

15 In certain embodiments, the reflective surface
16 incorporates a low frequency acoustic drive unit.
17 In other embodiments, the reflective surface
18 comprises a low frequency acoustic drive unit.

19

20 In preferred embodiments, the array includes first
21 and second high frequency drive units.

22

23 In preferred embodiments, the mounting means
24 includes a first portion supporting the midrange
25 drive unit and an arm portion extending from said
26 first portion and supporting the at least one high
27 frequency drive unit, whereby the at least one high
28 frequency drive unit is cantilevered in front of the
29 reflective surface.

30

31 Preferably, the mounting means comprises an air-
32 tight, sealed enclosure. Preferably also, the

1 mounting means is configured to minimise the baffle
2 area surrounding the drive units. Preferably also,
3 the baffle area is configured to curve away and
4 rearwards from the drive units.

5
6 Preferably, the means defining the reflective
7 surface comprises a reflector member. Preferably
8 also, the reflector member is secured to the
9 mounting means to provide an integrated, self-
10 contained drive array.

11
12 In accordance with a second aspect of the invention,
13 there is provided a loudspeaker comprising a cabinet
14 having an acoustic drive array in accordance with
15 the first aspect of the invention mounted therein.

16
17 Preferably, the loudspeaker includes at least one
18 low frequency drive unit in addition to the drive
19 units of the array.

20
21 It is known in the prior art to mount high frequency
22 drive units in a supporting structure that bridges a
23 low frequency drive unit so that the high frequency
24 drivers are disposed in front of the low frequency
25 drive unit. However, such prior arrangements do not
26 provide a reflective surface behind the high
27 frequency drive units having the advantageous
28 acoustic properties provided by the present
29 invention.

30

5

1 Embodiments of the invention will now be described,
2 by way of example only, with reference to the
3 accompanying drawings, in which:

4
5 Figs. 1 and 2 are, respectively, schematic sectional
6 side and plan views of an acoustic drive array
7 embodying the invention;

8
9 Fig. 3 is a front perspective view of a preferred
10 embodiment of a rear drive unit enclosure component
11 of the array of Figs. 1 and 2;

12
13 Fig. 4 is a front perspective view of a preferred
14 embodiment of a front drive unit mounting component
15 (frame) of the array of Figs. 1 and 2;

16
17 Figs. 5A and 5B are, respectively, front and rear
18 perspective views of a preferred embodiment of an
19 acoustic reflector component of the array of Figs. 1
20 and 2;

21
22 Figs. 6A and 6B are, respectively, rear and front
23 views of the reflector of Figs. 5A and 5B, and Fig.
24 6C is a section on line A-A of Fig. 6B;

25
26 Figs. 7A and 7B are, respectively, front and rear
27 views of the frame of Fig. 4, and Figs. 7C-7E are,
28 respectively, sections on lines A-A, B-B and C-C of
29 Figs. 7A and 7B;

30
31 Figs. 8A and 8B are, respectively, front and rear
32 views of the component of Fig. 3, and Figs. 8C-8E

1 are, respectively, sections on lines A-A, B-B and C-
2 C of Fig. 8A.

3
4 Referring now to the drawings, an acoustic drive
5 array 10 in accordance with one aspect of the
6 invention comprises a midrange drive unit 12 and at
7 least one high frequency drive unit 14 or 16, but
8 more preferably two (or more) high frequency drive
9 units: a tweeter 14 and a super-tweeter 16. The
10 drive units 12-16 are preferably mounted in a single
11 mounting component or frame 18, having apertures 20,
12 22 and 24 for receiving the drive units 12-16. The
13 frame 18 is in turn mounted to a rear enclosure
14 component 26 that, together with the frame 18 and
15 drive units 12-16, defines a sealed, air-tight
16 enclosure assembly 27, comprising a first chamber
17 portion 28, including the midrange driver 12, and an
18 arm portion 30 extending outwardly from the main
19 chamber portion 28 and including the high frequency
20 driver(s) 14, 16.

21
22 The enclosure assembly 27 is arranged in a fixed,
23 predetermined spatial relationship with means
24 defining a concave acoustic reflector 32, such that
25 the one or more high frequency drive units 14, 16
26 are cantilevered in front of the reflector 32 by the
27 arm portion 30. The enclosure assembly is
28 sufficiently rigid to prevent any significant
29 vibration of the arm portion in normal use. The
30 frame 18, component 26 and reflector 32 may be made
31 from die-cast aluminium, or from any other suitable
32 metals, alloys or plastics.

1
2 The characteristics of the reflector surface and its
3 relationship to the high frequency driver(s) 14, 16,
4 illustrated only schematically in Figs. 1 and 2, is
5 discussed in more detail below. In general terms,
6 the reflector 32 is rebated into the cabinet of a
7 loudspeaker incorporating the driver array and acts
8 as an acoustic diffuser, so that the array as a
9 whole simulates as closely as possible the acoustic
10 dispersion characteristics of a high frequency
11 driver mounted in an ideal spherical enclosure, and
12 so that these dispersion characteristics are
13 maintained regardless of the configuration of the
14 loudspeaker cabinet.

15
16 The reflector 32 defines an acoustically reflective
17 surface behind the high frequency drive unit(s) 14,
18 16 such that the high frequency directivity of the
19 loudspeaker is precisely controlled and rendered
20 insensitive to the effects of loudspeaker placement
21 (relative to the walls or other reflecting surfaces
22 of the listening room). This means that the
23 loudspeaker can be placed near to walls, or rebated
24 into a wall surface, without changing the dispersion
25 characteristics of the loudspeaker.

26
27 The reflector 32 presents a reflective surface that
28 is irregular and continuously varying, in terms of
29 the distance from the periphery of the reflector to
30 the high frequency drive unit(s) and the angle
31 between the reflective surface and the plane in
32 which the drive units are mounted. This arrangement

1 substantially eliminates any coherent reflections of
2 sound from the high frequency driver(s) that would
3 interfere with the direct sound. Sound from the
4 high frequency driver(s) is reflected from the
5 reflector in a multiplicity of different directions,
6 so that the sum of the various reflections at any
7 listening point and any given frequency is
8 effectively zero.

9
10 The arm portion 30 of the enclosure assembly is in
11 front of the reflector 32, so that the effect of the
12 reflector is to control rearward dispersion from the
13 high frequency drivers without compromising forward
14 dispersion.

15
16 The arm portion 30 is configured to minimise the
17 baffle area on which the high frequency drivers are
18 mounted, so that the effective radiating area at
19 high frequencies is reduced. This has the effect of
20 maximising the horizontal and vertical dispersion of
21 the loudspeaker at high frequencies, reducing
22 acoustic coloration (providing a more open, natural
23 sound) and enhancing image sharpness for arrays of
24 two or more loudspeakers (stereo pairs, "surround-
25 sound" arrays, etc.).

26
27 The reflector is configured and the high frequency
28 drivers arranged such that the majority of
29 reflections are from the peripheral edge *E* of the
30 reflector 32. The arrangement is effective for all
31 frequencies where the shortest distance *d* from the
32 sound source (i.e. the centre of the high frequency

1 driver) to a point on the peripheral edge E is equal
2 to or greater than half a wavelength at that
3 frequency. For example, if $d = 80$ mm, then the
4 reflector would be effective for all frequencies
5 above 2kHz. For practical purposes, the minimum
6 useful size for the reflector would be where the
7 distance d is about 30 mm. The effect of the
8 reflector reduces as the largest distance of the
9 peripheral edge E from the centre of the high
10 frequency driver increases, becoming negligible when
11 this distance approaches 155 mm or less.

12
13 Figs. 3 to 6 illustrate particularly preferred
14 embodiments of the frame 18, rear enclosure
15 component 26 and the reflector 32. The interior of
16 the component 26 is configured to accommodate the
17 rear portions of the drive units 12, 14 and 16 when
18 these are mounted in the frame 18 and the frame is
19 mated with the component 26. The front surface 34
20 of the frame 18 is generally convex, so that the
21 surface curves away and rearwards from the drive
22 units, while locating the drive units as close
23 together as possibly and minimising the baffle area
24 surrounding the units.

25
26 The frame 18 and component 26 further include
27 various apertures and bores 36, 38, 40 and the like
28 whereby they may be fastened together and the
29 enclosure assembly 27 may be mounted in a
30 loudspeaker cabinet by means of screws, bolts etc.
31

1 The reflector 32 defines a generally concave
2 reflecting surface 42 with a side wall 44 and a
3 peripheral flange 46 that would abut against the
4 front wall of a loudspeaker cabinet, in use. The
5 reflective surface 42 has a cutaway portion 43 to
6 receive part of the chamber portion 28 of the rear
7 enclosure component 26. The reflector 32 is
8 preferably secured to the assembled frame 18 and
9 component 26 and drive units to provide an
10 integrated, self-contained driver array for mounting
11 in any of a variety of loudspeaker cabinets.
12

13 In this embodiment, as best seen in Figs. 6A-6C, the
14 reflector 32 is generally elliptical in plan and the
15 reflector surface 42 has a quasi-ellipsoidal
16 configuration, by which it is meant that the surface
17 can be regarded as an ellipsoidal surface distorted
18 to remove any focal points. It will be understood
19 that the shape of the reflector periphery and/or
20 surface may be varied as long as they have the
21 required effect of diffusing reflected sound from
22 the high frequency drivers 14, 16.
23

24 In order to ensure that reflections from the
25 peripheral edge E of the reflector are diffused
26 effectively, the surface 42 is radiused around its
27 periphery to provide a smooth, convex transition
28 between the main concave surface and the outermost
29 edge. Preferably, the radius of curvature is of the
30 order of 7 mm.
31

11

1 Figs. 7 and 8 illustrate the preferred embodiments
2 of the frame 18 and component 26 in more detail.
3 Note the wiring port 48 in the rear surface of the
4 chamber portion 28 of component 26.

5
6 In the embodiment illustrated, the array comprising
7 the assembly 27 and the reflector 32 includes the
8 midrange drive unit 12 and high frequency drive
9 unit(s) 14, 16. However, the array can be modified
10 to include at least one low frequency drive unit
11 that may be mounted in the reflector 32, or which
12 itself may be configured to act as the reflector 32
13 (replacing the reflector). Where a low frequency
14 driver is mounted in the reflector, the boundary
15 between the outer periphery of the driver and the
16 surface of the reflector may be configured to
17 optimise the dispersion characteristics of the low
18 frequency driver, in a manner that is known in the
19 art. Where a low frequency driver replaces the
20 reflector, the required edge characteristics of the
21 reflector (such as the radius 48 referred to
22 above) may be obtained by means of a suitably
23 configured trim ring fitted to the periphery of the
24 driver or by suitable design of the periphery of the
25 driver itself.

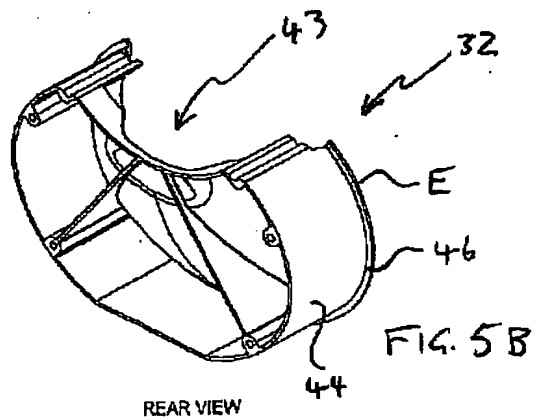
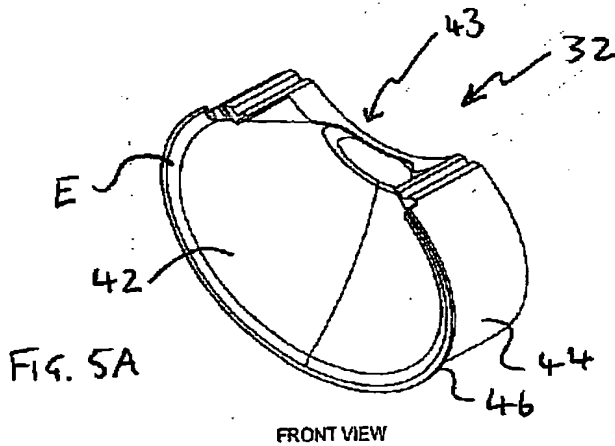
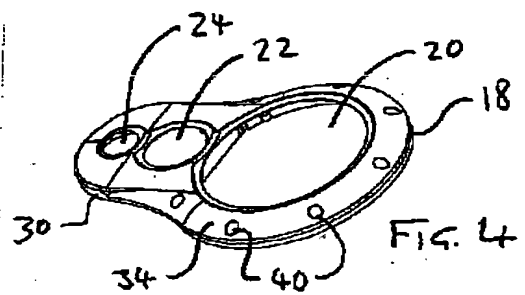
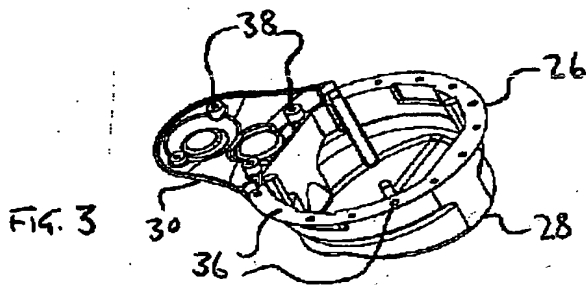
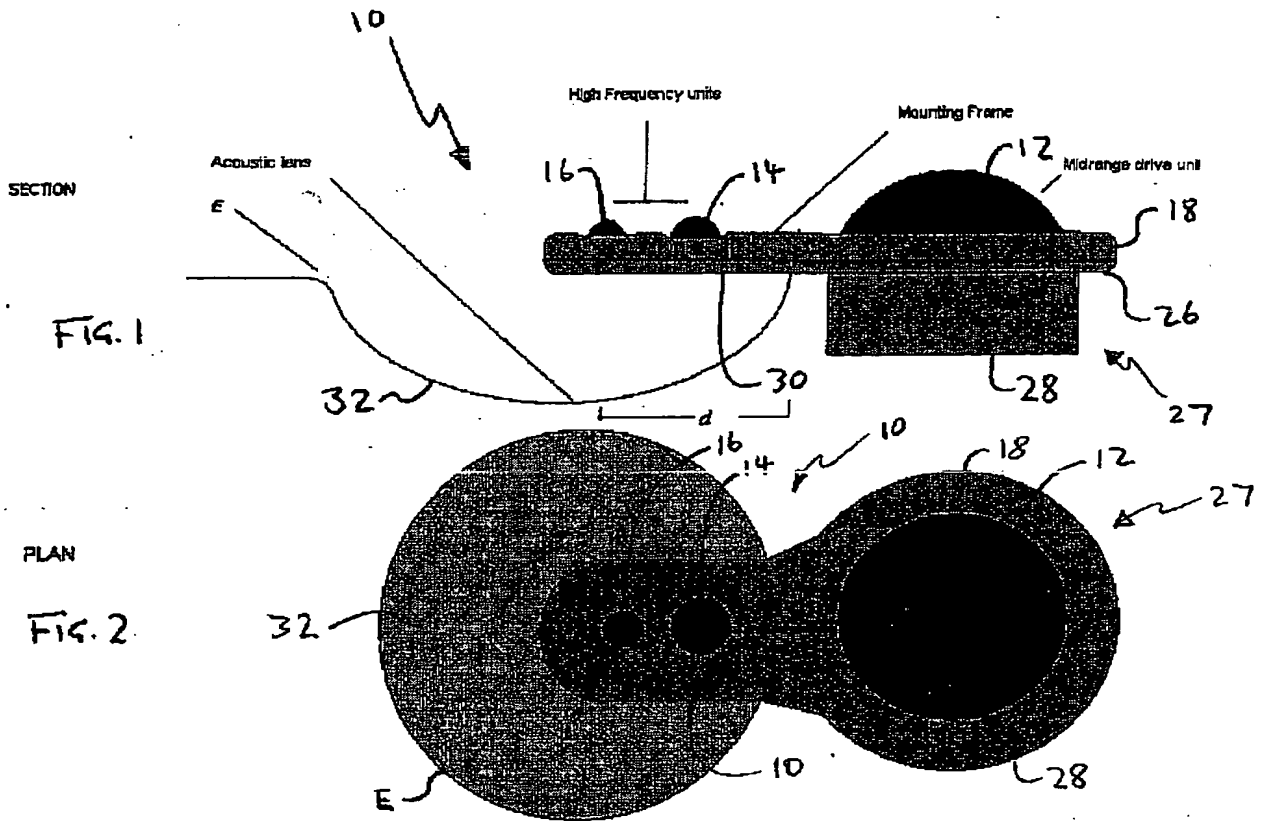
26
27 Acoustic drive arrays in accordance with the
28 invention can be incorporated into a variety of
29 types of loudspeaker cabinets which may or may not
30 include one or more additional drive units (normally
31 low frequency drive units). Where the array
32 includes its own low frequency driver, the array may

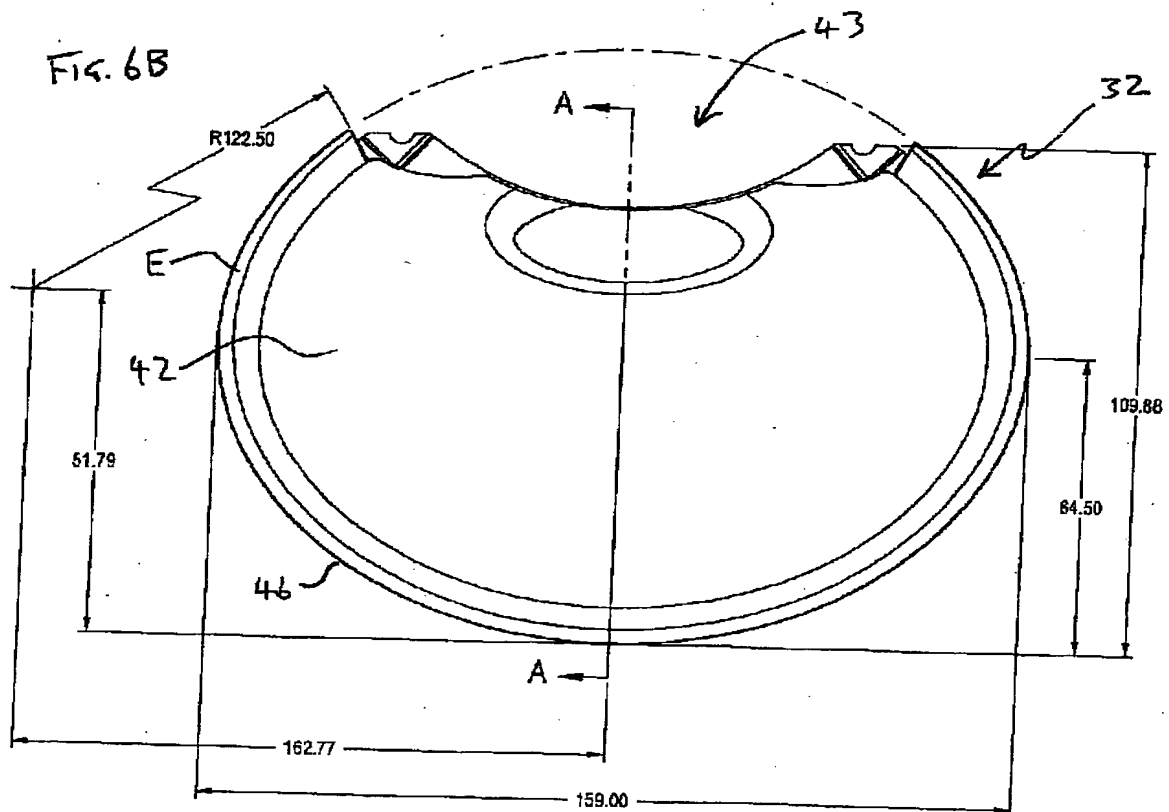
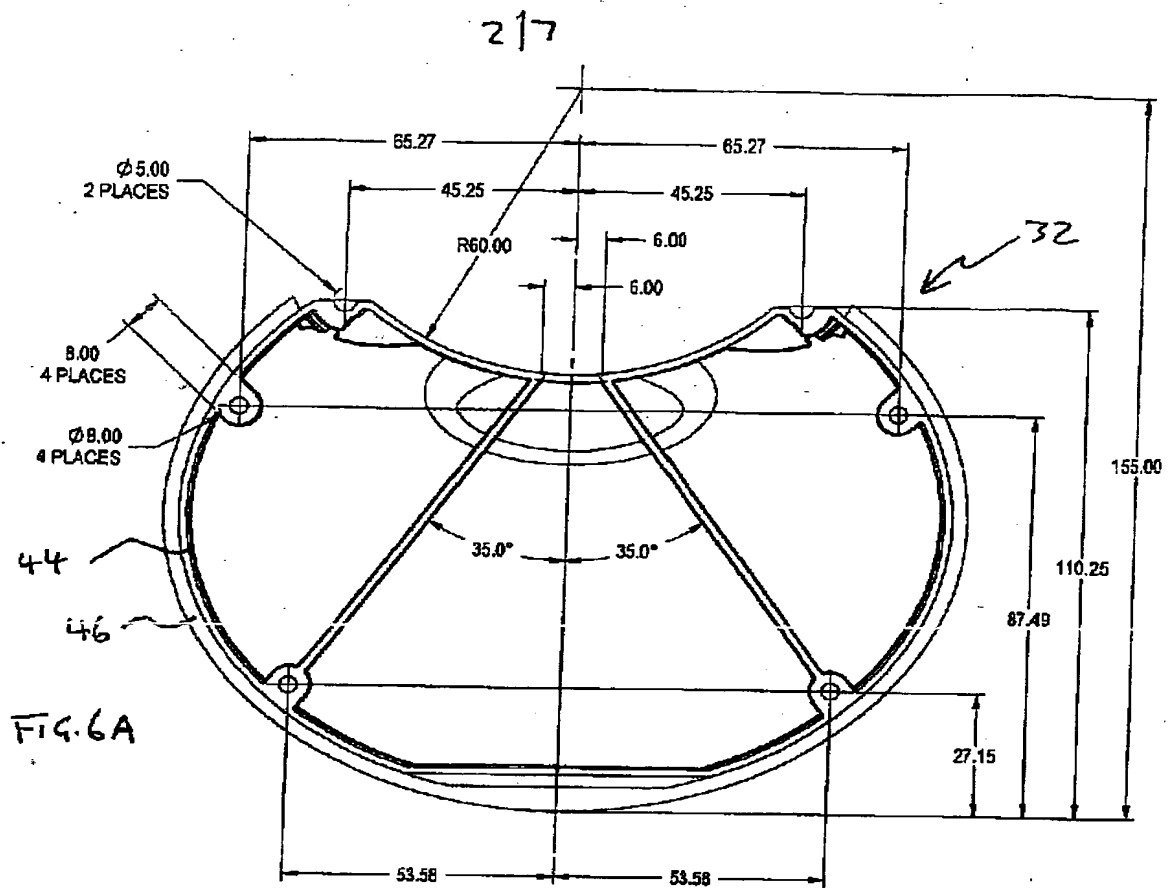
1 be mounted in a cabinet without additional drive
2 units to provide a complete loudspeaker. Whether or
3 not the array includes its own low frequency driver,
4 one or more additional low frequency drivers may be
5 included in the loudspeaker. Loudspeakers
6 incorporating the array, and/or audio systems
7 incorporating such loudspeakers, may have any of a
8 variety of well known crossover arrangements and/or
9 wiring configurations.

10
11 The invention provides the basis for a family of
12 loudspeakers employing similar acoustic drive arrays
13 in accordance with the invention such that all
14 members of the family have substantially identical
15 midrange and high frequency acoustic
16 characteristics.

17
18 Improvements and modifications may be incorporated
19 without departing from the scope of the invention.

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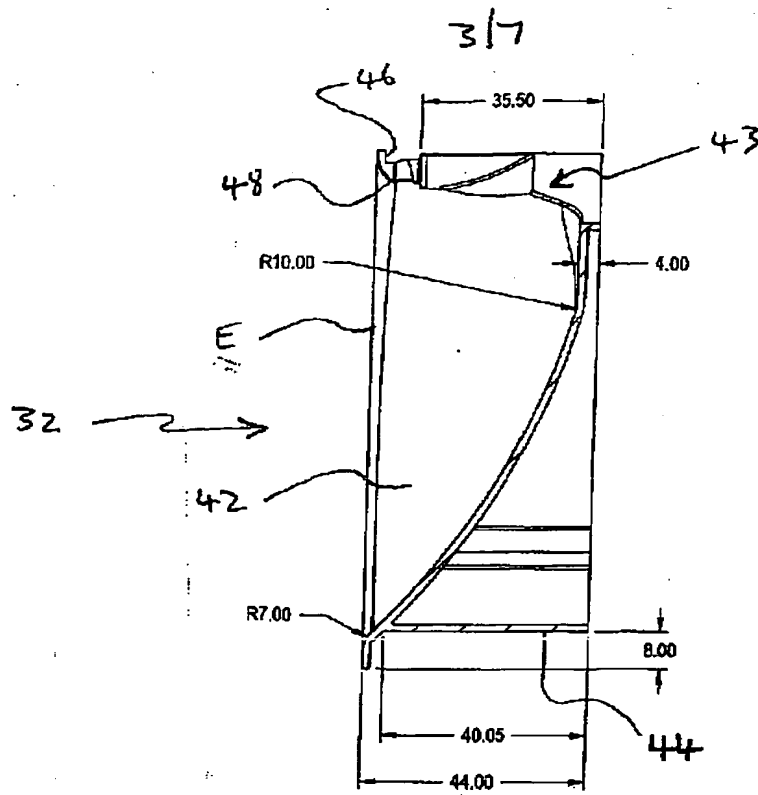
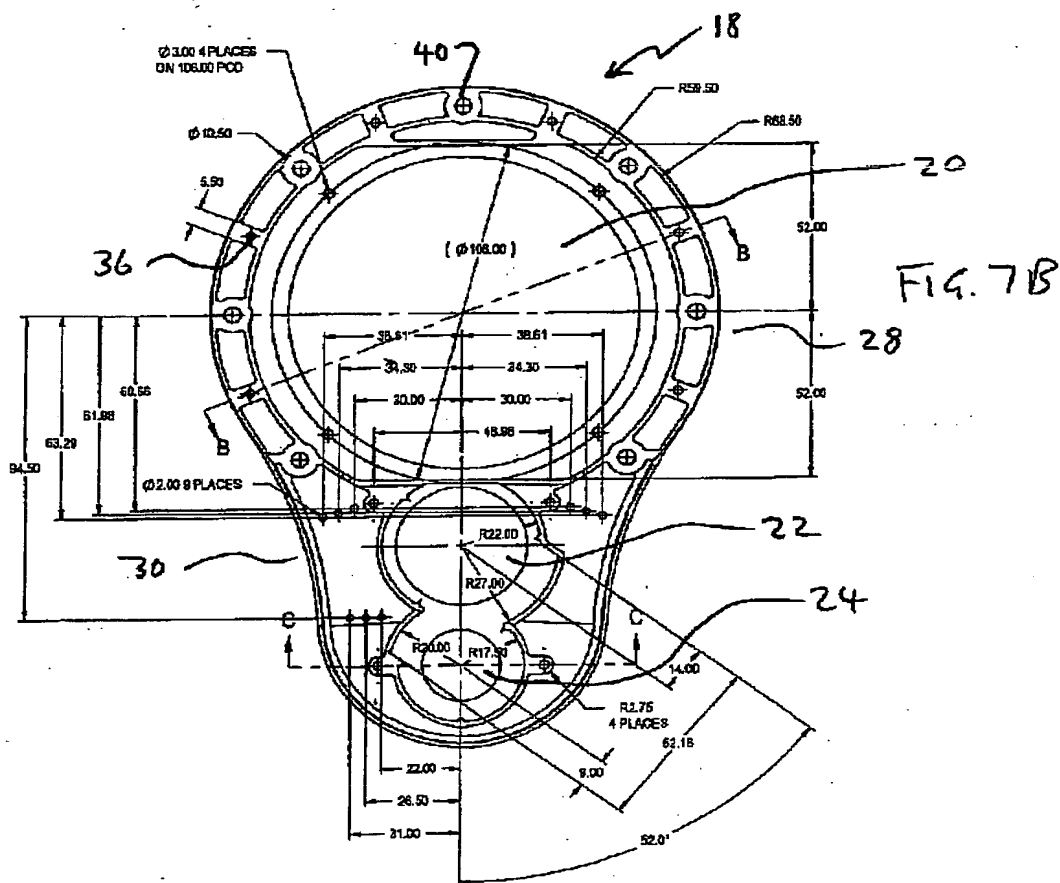
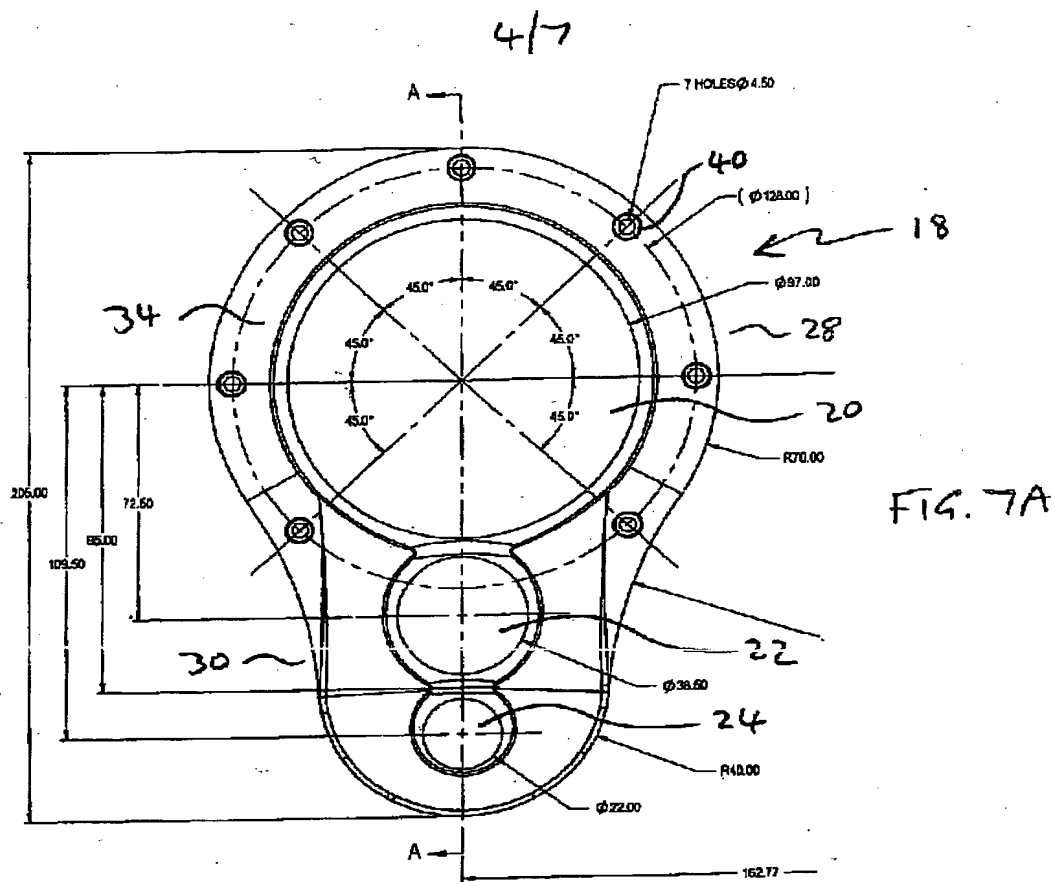
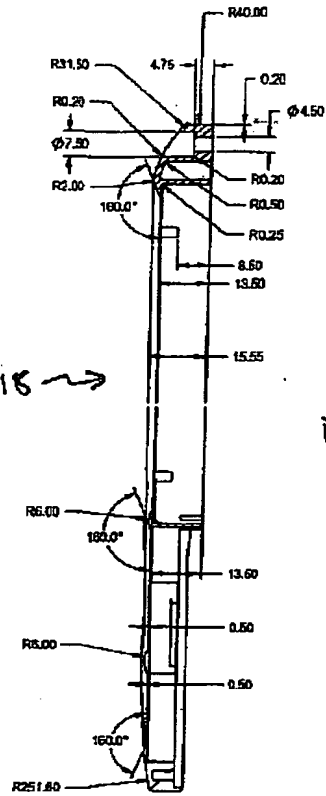


FIG. 6C

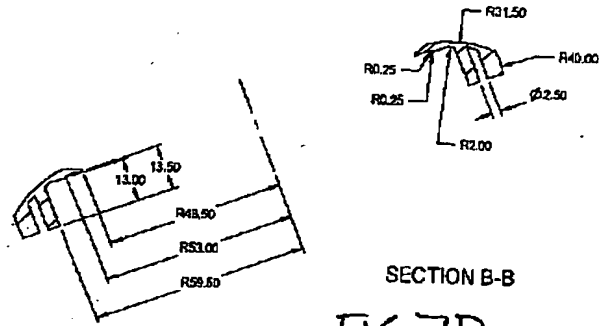


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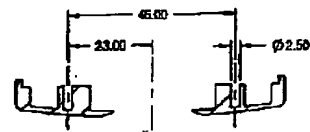
SECTION A-A

FIG. 7C



SECTION B-B

FIG. 7D



SECTION C-C

FIG. 7E

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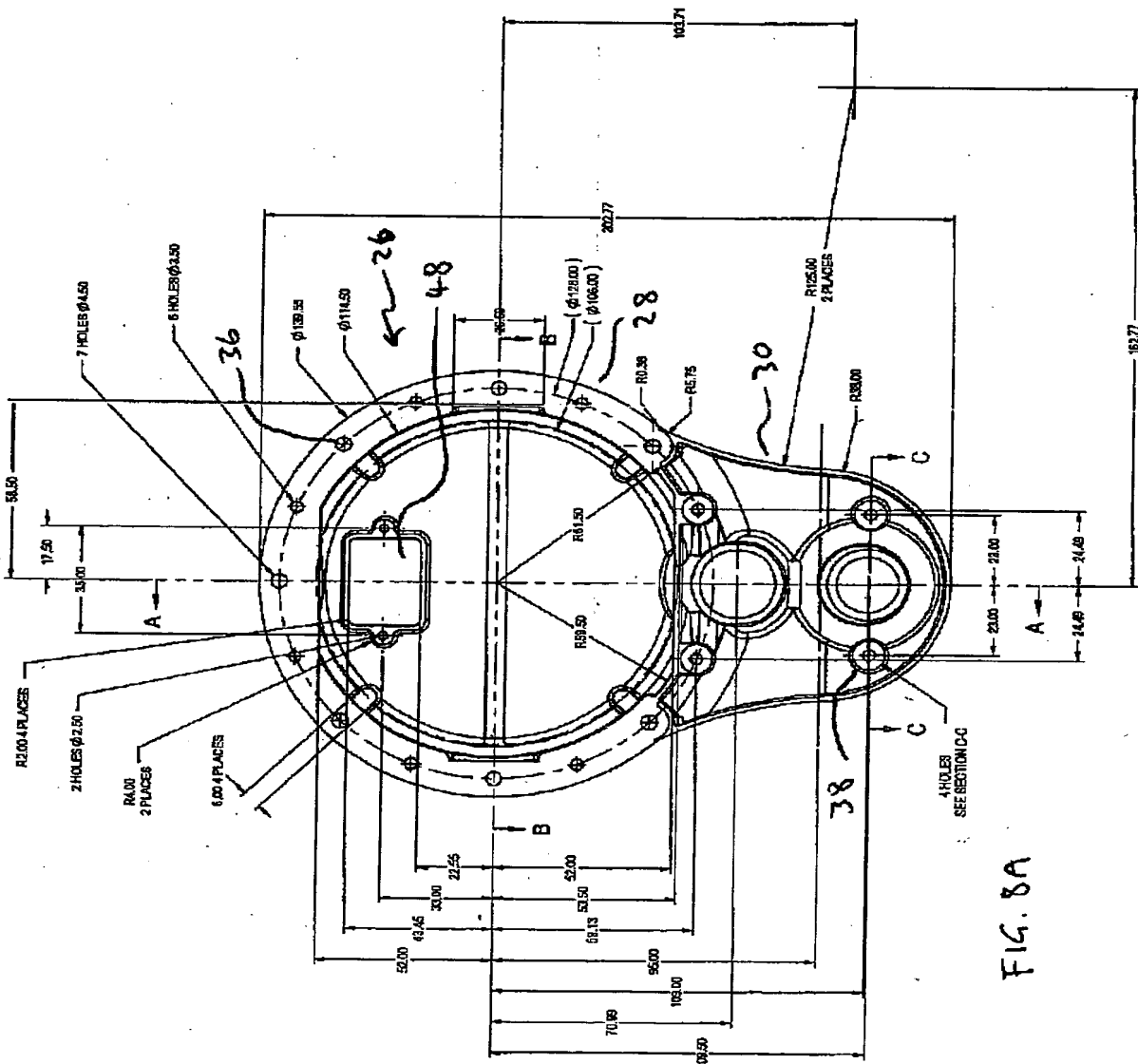
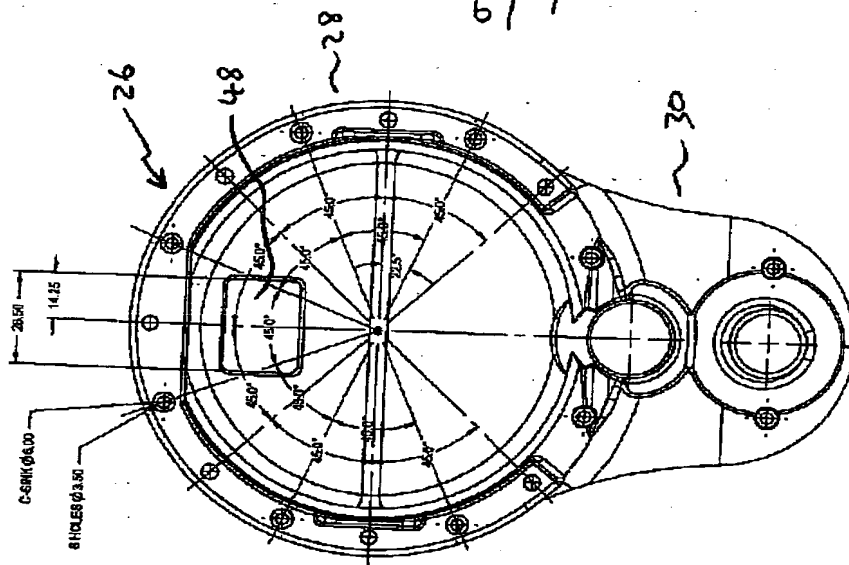


FIG. 8A

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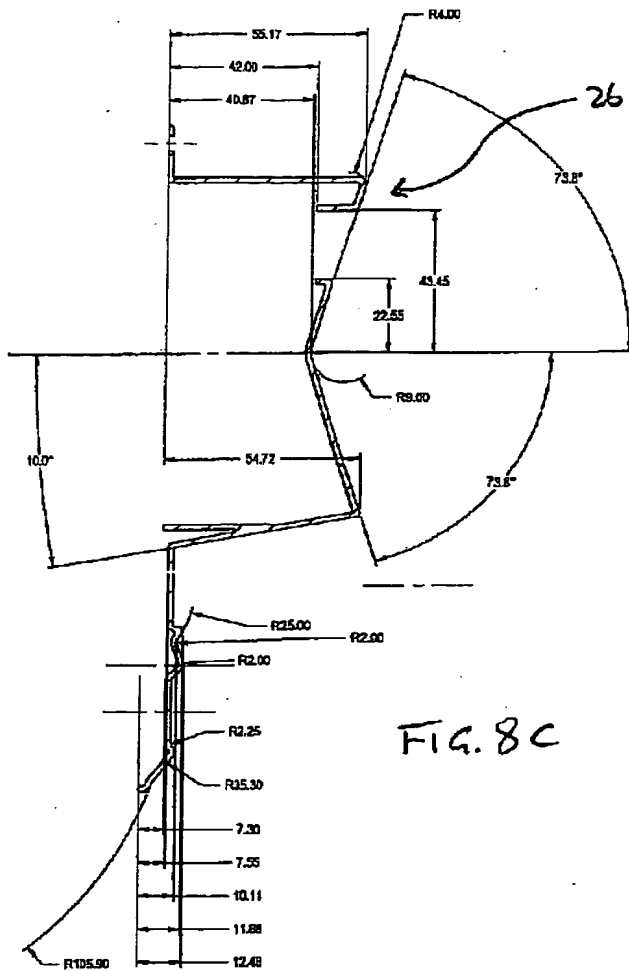
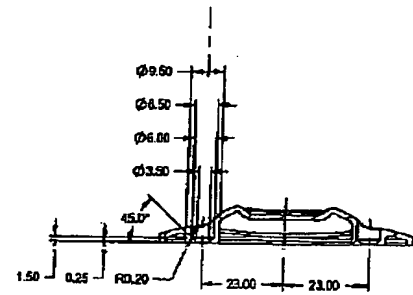


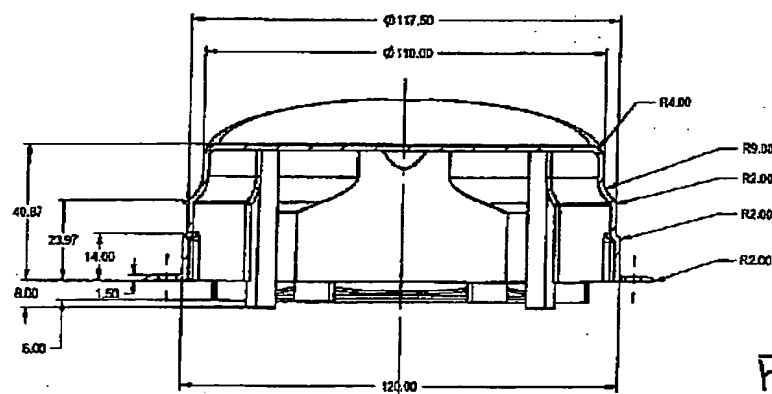
FIG. 8C

SECTION A-A



SECTION C-C

FIG. 8E



SECTION B-B

FIG. 8D

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